Long wavelength InGaAs/InGaAsP Quantum Well Lasersat ~2.0 μm

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Abstract

InGaAs/InGaAsP strained quantum well buried heterostructure and distributed feedback lasers emitting at wavelengths as long as 2.06 μm with low internal loss and threshold currents have been demonstrated for the first time. The room and high temperature characteristics and the threshold gain are discussed,

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Strained InGaAs/InP quantum well structures have been investigated as one approach for the development of semiconductor lasers in the spectral range of 1.6-2.3 μm (1-2), for chemical sensing and LIDAR applications. The high quality of InP substrates and the mature growth and processing technology of the InGaAsP alloy system make this technology attractive for devices that require laterally confined active layers and/or epitaxial regrowth. Broad area and ridge. waveguide lasers with threshold current densities comparable to those obtained in a more conventional wavelength range of 1.3-1.55 μm have been prepared. We present here buried heterostructure lasers and Distributed feedback lasers at a wavelength as long as 2.06pm which we believe is the longest wavelength achieved to-date in this material system. Their room and high temperature characteristics and threshold gain are discussed.

lasers with two, three, and four compressively strained $In_{0.75}Ga_{0.25}As$ wells, each 10 nm thick, were used in this study. The lasers with two quantum wells had barriers and confinement layers of InGaAsP with composition corresponding to a band gap of 1.3 μm. The other two structures used barriers of lattice matched InGaAs. The structures were grown by metalorganic vapor phase epitaxy (MOVPE) on (100) InP substrates. Capped mesa buried heterostructure lasers were fabricated around the 3.5 μm wide active layer mesa.

Fig. 1 shows the CW room temperature light-current characteristic of a buried heterostructure laser with two quantum wells. Light output of 14 mW (both facets) at a current of 200 mA was achieved. For 1 mm cavities threshold current densities were as low as 500 A/cm^2. The lasers with quaternary barrier structure operate at 1.94 pm. Lasers with three and four quantum wells and the ternary barriers showed an emission wavelength of 2.04-2.06 μm. Typical threshold current for all three structures were between 17-34 mA.

Fig. 2(a) and 2(b) show the length dependence of the threshold current density for laser active layers with two and four wells which provide insight into the gain of these highly strained quantum well lasers.

From the measurements of gain and index dependence of the carrier density, the linewidth enhancement factor for these highly strained lasers is determined which is twice the value observed in 1.3 and 1.5 μm lattice matched lasers.

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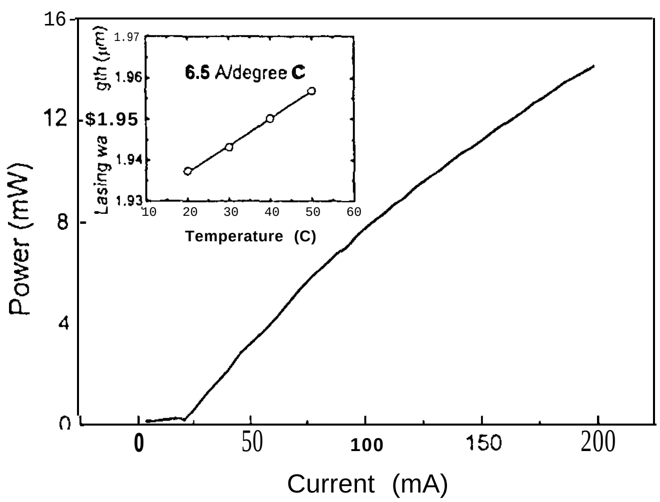

Fig. 1 Light-current characteristics for laser structure with quaternary barriers. Inset shows variation of lasing wavelength with operating temperature

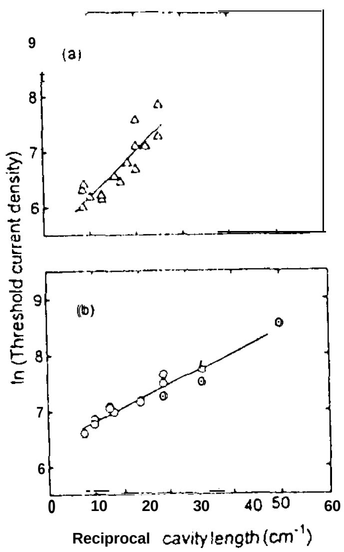

Fig 2 Dependence of threshold current density on inverse cavity length for laser active layers with (a) two wells and (b) four wells. The solid lines are a linear fit